Resurssiviisas taitoverkko

# Mobile Technology sleigh

Advanced Industrial Design Project 2025

Euroopan unionin osarahoittama

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Sää'm škooultemkööskös

# Technology Mobile Sled

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# Objectives

The objective of this project is the design and construction of two sliding devices intended to be attached to a snowmobile, thus facilitating the work of reindeer herders in northern Finland. These devices, designed for use on snowy terrain and in extreme weather conditions, respond to the need to optimize transportation and cargo handling in livestock activities specific to the region.

The first device is conceived as a modern reinterpretation, using lightweight and resistant materials that ensure durability and maneuverability. The use of composite materials and advanced alloys will be prioritized to maximize structural efficiency without compromising lightness. The modern design will consider not only functionality, but also ergonomics and adaptability to different types of snowmobiles, ensuring versatility and performance in diverse situations.

On the other hand, the second device will be inspired by traditional Sami sleds, characterized by their simple construction and use of natural materials native to the region, such as birch wood. This design aims to preserve the core principles of Sami tradition, with minimal adaptations to ensure integration with a snowmobile while maintaining its cultural and aesthetic essence.

Both designs will be evaluated through practical field tests, analyzing aspects such as stability, structural strength, and maneuverability. Additionally, comparative analysis will be conducted to assess the benefits and limitations of each approach, considering both functionality and respect for cultural tradition in contemporary product design.

The expected outcome is a product that is simple and feasible to build following clear instructions (in line with the "do it yourself" philosophy).

## General and specific objectives

**General objective**: To design and build two sliding devices attachable to a snowmobile, one traditionally inspired by Sami sleds and the other with a modern approach, to optimize transportation in snowy terrain and facilitate the work of reindeer herders in northern Finland.

**Specific objectives**: To conduct in-depth research into Sami tradition, learn how to design an object that spends its useful life in adverse conditions, develop 3D modeling, build prototypes for testing in real-life conditions, and compare the results of both designs.

# Project Context

The design of these sleds for reindeer herders arose from the need to adapt cargo transport to the harsh Arctic climate conditions in northern Finland and the border regions between Finland, Sweden, and Norway. In this geographical and cultural context, dominated by Sami traditions and life in snowy and extreme environments, it is important to propose innovative solutions that facilitate the daily work of herders and herders.

Currently, cargo transport in snowy conditions presents several challenges. For example, reindeer herders face difficulties handling tracking devices and antennas while wearing gloves. This is exacerbated by low temperatures, which also affect the battery life of drones and other electronic equipment essential for livestock monitoring. These limitations highlight the need to improve both

traditional methods and incorporate modern technologies that optimize transport and monitoring in snowy areas.

Traditionally, herders used animals to follow the herd, which allowed them limited mobility in terms of load and endurance. However, using a snowmobile coupled to a sled offers significant advantages, allowing heavier loads to be transported for longer periods without the fatigue associated with using animals alone. Although a potential disadvantage is the noise produced by the snowmobile, the advantage in terms of efficiency and operational capacity is undeniable.

The use of modern and innovative materials is another cornerstone of this project: greater durability, thermal insulation to protect electronic devices, and a lighter and stronger structure. These materials not only make it possible to create a sled with a long lifespan, but also improve the efficiency of reindeer tracking, facilitating the integration of advanced technology into the device.

To explore all possibilities and evaluate optimal performance, it was decided to develop both traditional and modern versions of the sled. This dual approach will allow results to be compared, improvements to be identified, and those elements that already achieve high performance in everyday use. The impact of this project on the reindeer herders' quality of life could be very positive, as it facilitates fieldwork and animal tracking, making the work accessible and less tiring. Furthermore, the implementation of a more efficient and modern design has favorable economic implications, reducing costs and simplifying the device's construction.

Regarding technological integration, the sled has been designed with three distinct compartments: a personal compartment for belongings and clothing, another equipped with a power generator and materials for minor repairs to the snowmobile, and a third thermoregulated space designed to protect the drone batteries, tablets, and the tracking antenna from the cold. The space will reach a height of approximately 8 meters and will be removable and stored in a side tube of the sled. To ensure that the technological equipment remains in optimal condition even in extreme climates, an insulation lining will be included inside the box for these devices, guaranteeing a warm and stable environment for their operation. In short, this project responds to the growing need to adapt means of transport in snowy environments through innovation in design and materials, benefiting both operational efficiency and the quality of life of reindeer herders in a challenging environment.

# Project Development

## Traditional Sled Design: keeping alive the northern spirit

While our sled design isn’t a direct replica of a traditional Sámi sled, it was inspired by the Sámi Museum in Inari. Unlike the original Sámi sled, which lacks skis, ours incorporates them—drawing from Finnish wood-transport sleds and concepts outlined in Norvapalo’s documentation.

The traditional *parireki*, or Sámi wooden sled, is a handcrafted vehicle used in snowy northern Scandinavia. It holds cultural significance, especially among the Sámi, and was vital for winter transportation. The craft is both functional and a means of preserving heritage, with detailed manuals by Esko Norvapalo offering key insights into this tradition.

### *Historical background*

The inspiration for these construction manuals comes from a revival of interest in traditional methods during the late 1970s and early 1980s. Esko Norvapalo, influenced by his father's

sled-making experience, decided to learn and document the process. Initially experimenting with older models, such as the *kolmitakkanen* (a three-runner sled), he eventually settled on a refined and more manageable version of the double-runner sled (*parireki*) but making it smaller.

Norvapalo conducted research by interviewing elderly craftsmen and measuring museum pieces to derive accurate dimensions and proportions.

### *Materials and preparation*

The primary material for the sled is wood, preferably birch or spruce. The logs must be carefully selected, ensuring that the heartwood is removed. They are sawn and dried in a ventilated shelter throughout spring and summer, then moved indoors in the fall. The drying process can take up to a full year to ensure the wood is suitable for bending and shaping.

Each wooden piece is cut slightly longer than needed to allow for cracking at the ends and for better handling during shaping. For curved parts such as the front runners (keel arches), the wood is either steamed or boiled to make it pliable before being bent into shape using custom-made jigs and secured with clamps and metal braces to prevent splitting.

### *Shaping and assembly*

The sled is composed of two main runners (*jalakset*), the long wooden rails that glide over the snow. These are the most critical components, requiring precise shaping for balance, stability, and glide. They are planed, sanded, and carved using templates to achieve symmetry. The runners are made slightly different lengths, with the rear sled longer to carry heavier loads and maintain a backward weight distribution that helps the sled rise over deep snow rather than sink.

*Ketarat*, or support brackets, connect the runners to the *pankot* (crossbeams that serve as the sled's framework). The connections are crafted using tenon joints and reinforced with tarred surfaces and wooden wedges. This tar treatment protects the wood from moisture and rot and is a traditional method that gives the sled a deep blackened hue over time.

### *Rekka – The load platform*

On top of the sled framework, a detachable platform called the rekka is mounted. This part carries the actual cargo, which could range from firewood and tools to hay, reindeer meat, or even passengers. The *rekka* is designed to be lightweight yet strong, often constructed from pine boards. It is secured with ropes (traditionally hemp) and metal hooks, avoiding modern ratchet straps that could damage the flexible wooden frame.

### *Finishing touches*

Additional elements such as *kaustat* (curved side arms made from naturally bent wood), *lumilaudat* (snowboards to block snow from entering), and *hilaketjut* (safety chains) are added last.

Finally, the sled is tarred entirely and left to cure. This final coating not only preserves the wood but enhances the detailed carvings, revealing their grain and form.

### *Cultural significance and continuity*

While the *parireki* is no longer essential for modern transportation, its construction remains a living tradition. It embodies values of sustainability, craftsmanship, and adaptation to nature.

These sleds are not merely tools, they are reminders of the northern identity and a tribute to ancient people living in the artic.

In our design in the *rekka* we will be attaching three wooden boxes with ropes.

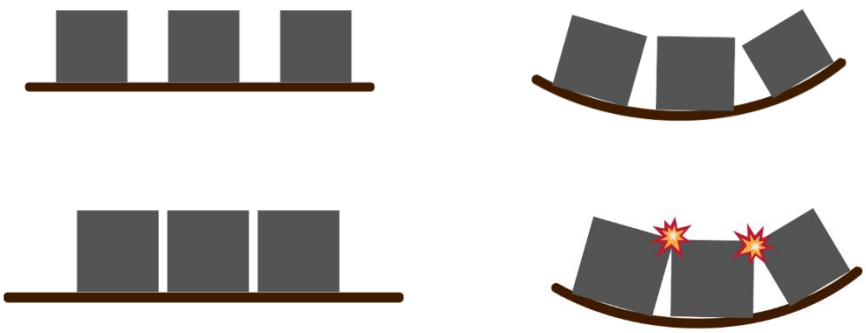
## Modern Sled Design: keeping up with the new technologies

Following an initial phase of competitor analysis and review of similar products, a company with a particularly relevant approach was identified. Based on this analysis, the KARYON brand was chosen as the main reference. KARYON sleds stand out for their innovative and functional design, employing lightweight and durable materials. Additionally, their products prioritize flexibility and durability, adapting to extreme conditions without compromising the user experience.

Another advantage identified during the study was the modular nature of KARYON sleds. These models allow multiple units to be assembled in series, enabling them to be towed simultaneously by a single snowmobile, thereby increasing transport capacity. Furthermore, the sleds include multiple anchoring points distributed along the structure, facilitating the secure fastening of various types of cargo. This versatility allows them to accommodate bulky items, long objects, or small-sized equipment, optimizing functionality according to the user's specific needs.

From the beginning of the project, a key requirement was the inclusion of three storage boxes intended to safeguard materials and items needed for livestock activity. These boxes will be secured to the sled via three independent metal structures, each specifically designed to house one box. The support structure will be made of aluminum, a material that offers an optimal balance between mechanical strength and lightness.

The decision to use three separate structures addresses the need to provide the sled with greater structural flexibility. This configuration, with approximately 15 cm between each structure, allows the system to adapt more efficiently to the irregularities of snowy terrain. In this way, excessive stress typical of overly rigid structures is avoided, and collisions between boxes are minimized, which helps protect the transported load. As a result, both performance and durability of the prototype are optimized under real-use conditions.



## Transport Boxes Design: generator, electronics and personal box

The boxes were divided into three groups:

**PERSONAL:** This box is intended for storing personal items, clothing, and food. Its design has been optimized to be as light as possible, as it will be the first to be moved inside the cabin upon arrival. This feature is essential to facilitate handling and ensure that personal items are protected and easily accessible from the start.

**ELECTRONICS:** The electronics box is designed to transport a battery that allows charging tablets, mobile devices, and livestock tracking equipment. Additionally, it will serve as a shelter for drones

used in surveillance tasks. For this reason, a thermoregulation system has been incorporated to maintain an internal compartment with a temperature higher than the outside, protecting the batteries from extreme cold. Although it is heavier than the personal box, its design allows a single person to handle it easily to ensure it is stored in the cabin during adverse weather conditions.

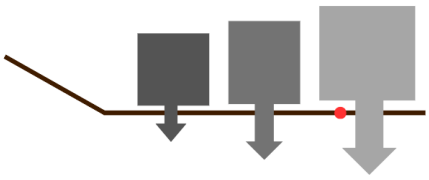
**GENERATOR:** The box for the generator has enough space to house an energy generator, two gasoline bottles for the snowmobile, and a box with basic tools for making simple repairs on the snowmobile, sleds, and, if necessary, the other boxes. This unit is the heaviest of all and is designed to remain in a fixed location, so personal transport is not planned. It will stay outdoors next to the snowmobile when reaching the cabin, providing robust and secure support for energy and maintenance operations.

### *Size specifications of the boxes*

| | Height | Length | Width | | Height | Length | Width | joints |
|---|---|---|---|---|---|---|---|---|
| **Personal stuff box** | | | | | | | | |
| Bottom | | 600 | 750 | | | 600 | 750 | 4 |
| Left | 591 | 600 | | | 586,5 | 600 | | 3 |
| Right | 591 | 600 | | | 586,5 | 600 | | 3 |
| Front | 591 | | 750 | | 586,5 | | 741 | 3 |
| Back | 591 | | 750 | | 586,5 | | 741 | 3 |
| Lid | | 614 | 778 | | | 614 | 778 | 3 |
| left lip | 50 | 614 | | | 45,5 | 605 | | 2 |
| Right lip | 50 | 614 | | | 45,5 | 605 | | 2 |
| Front lip | 50 | | 778 | | 45,5 | | 778 | 3 |
| **Electronics box** | | | | | | | | |
| Bottom | | 500 | 750 | | | 500 | 750 | 4 |
| Left | 591 | | 750 | | 586,5 | | 750 | 3 |
| Right | 591 | | 750 | | 586,5 | | 750 | 3 |
| Front | 591 | 500 | | | 586,5 | 491 | | 3 |
| Back | 591 | 500 | | | 586,5 | 491 | | 3 |
| Lid | | 764 | 528 | | | 764 | 528 | 3 |
| left lip | 50 | 764 | | | 45,5 | 755 | | 2 |
| Right lip | 50 | 764 | | | 45,5 | 755 | | 2 |
| Front lip | 50 | | 528 | | 45,5 | | 528 | 3 |
| **Generator box** | | | | | | | | |
| Top | | 150 | 700 | | | 150 | 700 | 2 |
| Bottom | | 750 | 700 | | | 750 | 700 | 4 |
| Left | 600 | 750 | | | 591 | 750 | | 4 |
| Right | 600 | 750 | | | 591 | 750 | | 4 |
| Front | 130 | | 700 | | 125,5 | | 691 | 3 |
| Back | 591 | | 700 | | 586,5 | | 691 | 3 |
| Generator lid | | 314 | 728 | | | 314 | 728 | 3 |
| Generator front | 490 | | 728 | | 485,5 | | 728 | 3 |
| Generator left | 490 | 332 | | | 485,5 | 323 | | 2 |
| Generator right | 490 | 332 | | | 485,5 | 323 | | 2 |
| Fuel lid | | 314 | 728 | | | 314 | 728 | 3 |
| Fuel front | 50 | | 728 | | 45,5 | | 728 | 3 |
| Fuel left | 50 | 314 | | | 45,5 | 309,5 | | 2 |
| Fuel right | 50 | 314 | | | 45,5 | 305 | | 2 |
| Inside wall | 582 | | 682 | | 582 | | 682 | 0 |

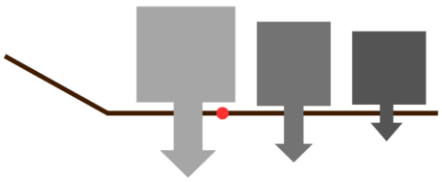
| | | | |
|---|---|---|---|
| support piece lids x2 | | 600 | 50 |
| insidewall support side x2 | | | 20 |
| insidewall support front x2 | | | 20 |
| support piece front x2 | | 600 | |
| | | | |
| **Electronic rack** | | | |
| Bottom | 18 | 220 | 660 |
| Sides x2 | 509 | 220 | |
| Front | 454 | | 642 |
| Top | | 211 | 642 |
| shelf | | 211 | 642 |
| | | | |
| **Electronic insidebox** | | | |
| Bottom | | | |
| Sides x2 | 482 | 666 | |
| Front+back | 482 | | 416 |
| coverpiece short | | | |
| cover piece long | | | |

## *Weight distribution*



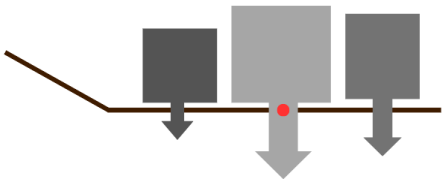
**Improper weight distribution:** The heaviest box is placed at the rear of the sled. This shifts the center of gravity rearward, which can cause:

- Instability when turning or braking
- Increased risk of sled lifting off the front or losing control
- Uneven wear on the skis



**Improper weight distribution:** the heaviest box is placed at the beginning of the sled. This shifts the center of gravity to the first third of the toboggan, which can cause:

- The sled's front end may dig into soft snow
- Uneven wear on the skis
- Lifting off the end of the sled and losing control



**Proper weight distribution:** The heaviest box is placed in the center of the sled. This position allows the center of gravity to remain balanced, which improves:

- The overall stability of the sled
- Control during movement, especially when turning or braking
- Even weight distribution on the skis

## Tracking System Design: remote control and antenna for reindeer monitoring

One of the first requirements given to us when the project information was provided was to facilitate the task of assembling and disassembling the tracking devices used for monitoring reindeer herds. This tracking system consists of several components. The first is the antenna, which is responsible for receiving and amplifying the signals sent by the controller to the satellites, which then relay the signals to the animal tracking devices and back, allowing the location of the animal to be determined.

Additionally, we will need a remote control to assist in positioning the antenna correctly. This remote will also convert the energy signals into visual signals, ensuring optimal readability for the operator.

The shape of the controller is intentionally larger than strictly necessary, due to two main considerations: the low temperatures in which the device will be used, requiring the operator to wear bulky gloves, and the generally larger hand size of the Sámi population, the primary users of the device.

The cable exits from the bottom of the controller.
It is designed to be held in the left hand, as the right hand is typically used to adjust and orient the antenna.

The interface features three large lights instead of buttons, prioritizing visibility and simplicity.

- The triangular light indicates whether the device is powered on and operational.
- The unit-shaped lights display speed.
- A horizontal bar-shaped light indicates signal strength, helping the user to optimally align the antenna.

The controller housing is secured with screws, strategically placed to avoid interference with the main circuit board and the LED components. This ensures both structural integrity and ease of maintenance without compromising the internal layout.

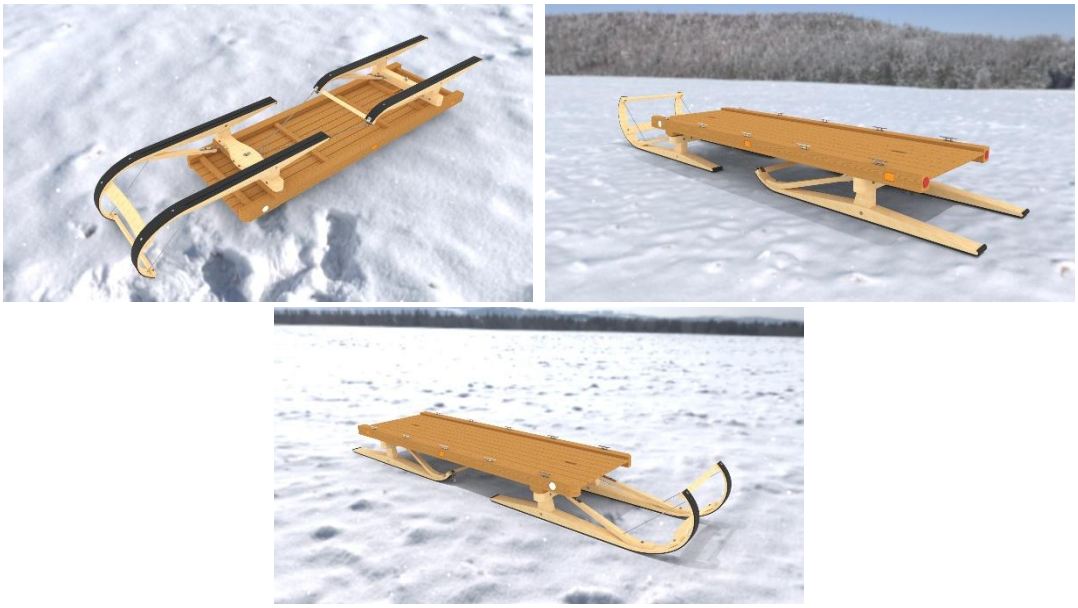
Finally, the antenna needs to be elevated to perform its function as effectively as possible. We decided to implement a little over two meters tube attached to one of the boxes (the middle one on the toboggan) and to the *rukka* on the wooden sled. This tube will store three aluminum sections, which can be assembled to provide a six-meter height pole for the antenna.

# From Concept to Model: 3D and prototype

## Prototype development

### Wooden sled

*Blueprints and renders*



Renders of the wooden sled

*Materials*

The materials used are wood, preferably birch or fir. Our sled was made of birch. Tar is also needed, a liquid used to protect the sled from inclement weather, snow moisture, and ski rot. We also reinforced the skis by adding a piece of the same PE 300-plyeteeni as the toboggan.

*Process*

As previously mentioned in this document, tree trunks are carefully selected and cut, avoiding the heartwood, which contains denser and less flexible fibers unsuitable for forming the curved skis of the sled. Each trunk is divided into segments that are intentionally cut longer than the required dimensions to accommodate potential end-cracking during the drying process.

Once the wood sections have adequately dried, they are cut and shaped according to the design specifications. The shaped pieces are then placed in a steam oven to soften the fibers, allowing the wood to be bent into the curved profile needed for the skis.

While still pliable, the pieces are clamped into molds reflecting the final desired curvature and left to cool and set in shape. After all components have been formed and conditioned, they are assembled and bonded using appropriate adhesives. Finally, a protective layer of tar is applied to shield the sled from environmental exposure and wear.

We also carved out some pieces of wood to attach rear reflectors to make it easier to find and safer on dark nights. In this case, by recessing the reflectors into the surface of the sled's wooden skis, they sit flush with the exterior. This design ensures that if the sled collides with a tree, the reflectors remain protected.

The boxes on this sled are placed side by side because it is not flexible; they rest on top of the rukka.

## Toboggan

*Blueprints and renders*

Renders of the boxes in the toboggan
Photo (1), photo (2) and photo (3) outside of the sled and closed boxes
Photo (4) detailes render of the inside of the electronics box
Photo (5) inside of the generator box with the gas tanks
Photo (6) inside of the generator box with a detailed generator render

*Materials*

PE 300 8mm thick, bolts with rounded edges, and the springs to attach the toboggan to the sled. (custom made by a shop in Rovaniemi) ready hooks already made that we weld into the frames. The structure was also painted with a special exterior paint, which will protect the steel from adverse

weather conditions and give the sled a more professional appearance, in addition to making it easier to spot the sled at night. Before the trip, we discovered that the aluminum and steel frames were reacting with each other, causing the aluminum to deteriorate. To prevent this, we added rubber material around the steel structures.

*Process*

The prototyping process of the toboggan model was carried out in two distinct phases. The first involved the construction of the sled body itself, which was designed as a polyhedral structure, featuring a rectangular base that narrows into a triangular shape at one end. Six rail elements were also cut and attached to the underside of the sled to simulate skis, enabling it to glide smoothly over the snow.

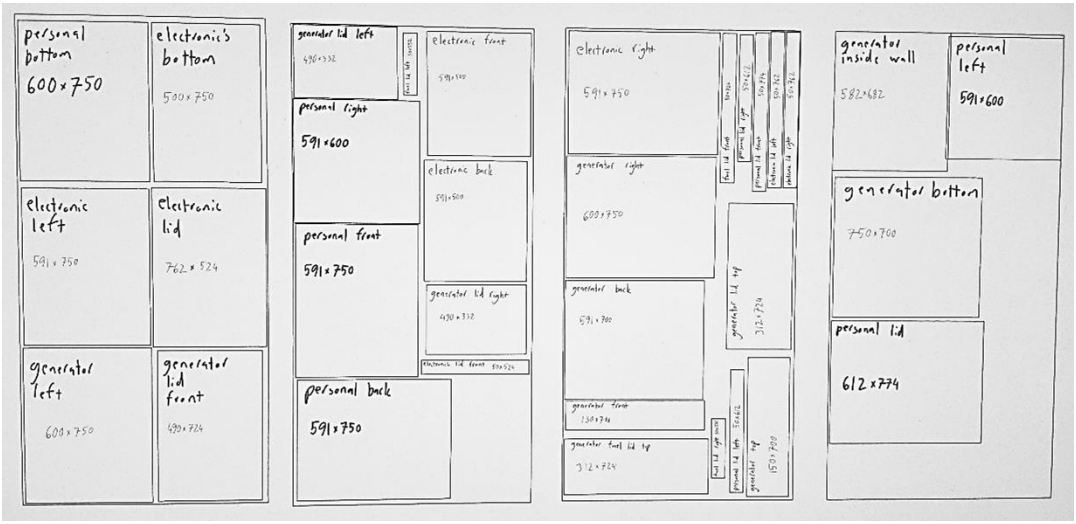
The second phase centered on metalwork. Three custom steel frames were fabricated to securely hold the cargo boxes on the sled while keeping them physically separated from the sliding surface. Each frame consisted of a rectangular structure with two vertical legs that connected to the toboggan and included hooks to fix the boxes in place. Ready hooks were also welded onto the steel structures to facilitate fastening the boxes with ropes.

One significant design compromise had to be made regarding the angle between the front of the sled and the ground. Ideally, this angle would have been wider (more obtuse), to improve stability and handling. However, due to the fixed height of the snowmobile hitch we planned to use for towing, combined with the limited material length (3 meters instead of the optimal 3.5 meters or more), the angle had to remain as built.

After field testing during the trip, several improvements were identified. For instance, we noticed that the length of the legs was good after the snowstorm and we were wondering if they would be helpful as well if they were shorter. Their current height allowed snow to not accumulate around them during towing, which affected performance and efficiency. These insights will be valuable for refining future iterations of the sled design. For example, making them shorter takes less material and would be cheaper.

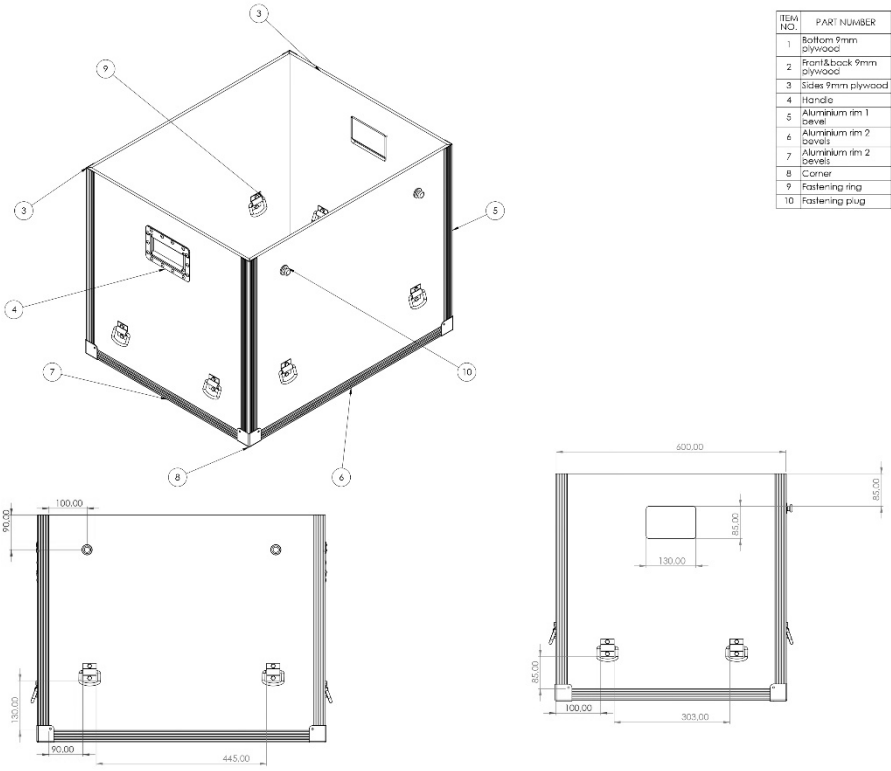
## Boxes

*Blueprints and renders*



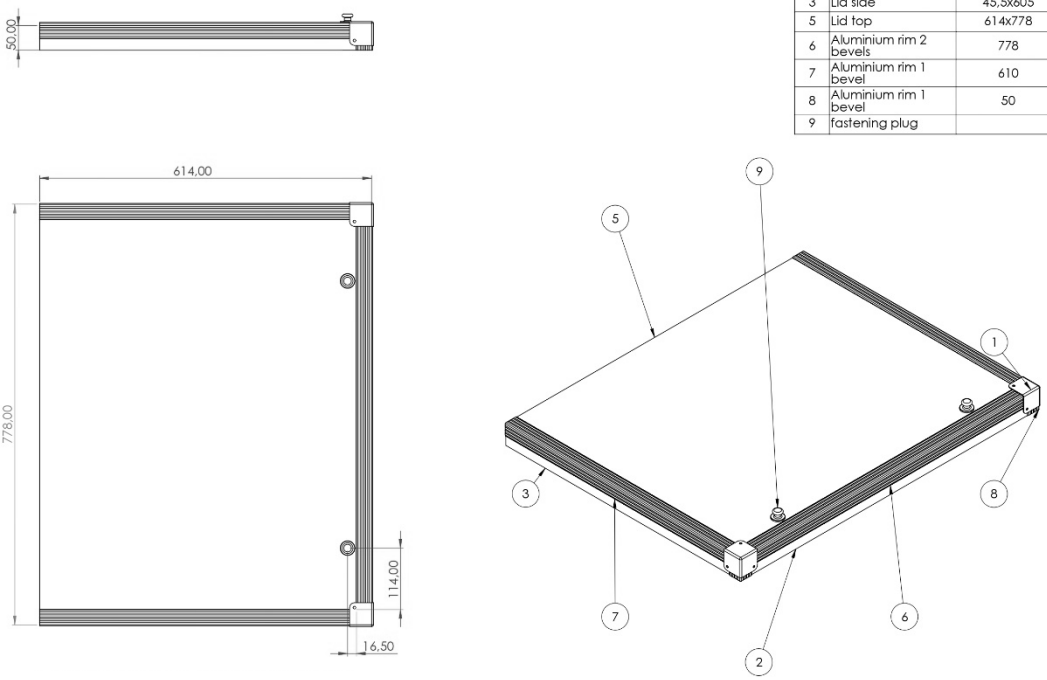

Layout of all the components that make up the boxes

| ITEM NO. | PART NUMBER | MEASUREMENTS mm | QTY. |
|---|---|---|---|
| 1 | Bottom 9mm plywood | 600x750 | 1 |
| 2 | Front&back 9mm plywood | 586,5x741 | 2 |
| 3 | Sides 9mm plywood | 586,5x600 | 2 |
| 4 | Handle | | 2 |
| 5 | Aluminium rim 1 bevel | 590 | 4 |
| 6 | Aluminium rim 2 bevels | 750 | 2 |
| 7 | Aluminium rim 2 bevels | 600 | 2 |
| 8 | Corner | | 5 |
| 9 | Fastening ring | | 16 |
| 10 | Fastening plug | | 4 |

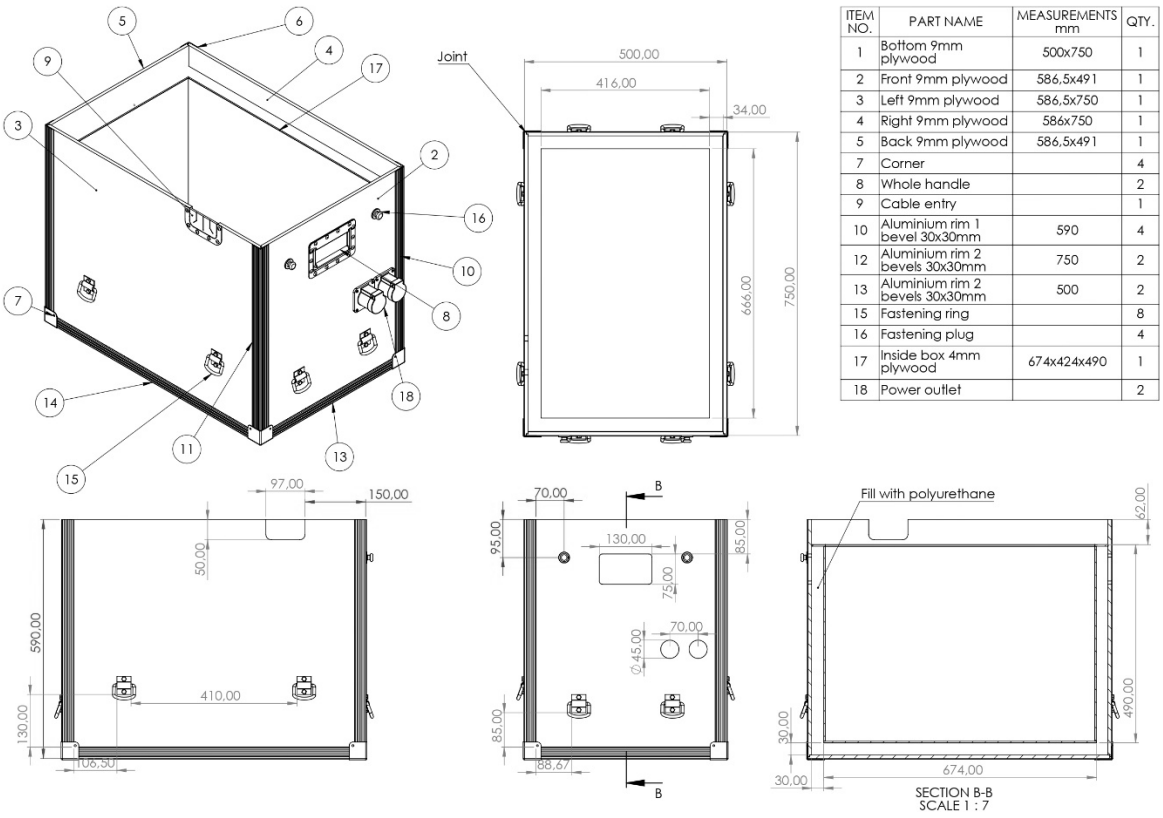



Technical drawings and measurements of the personal box

| ITEM NO. | PART NUMBER | MEASUREMENTS mm | QTY. |
|---|---|---|---|
| 1 | Corner | | 2 |
| 2 | Lid front 9mm plywood | 45.5x778 | 1 |
| 3 | Lid side | 45,5x605 | 2 |
| 5 | Lid top | 614x778 | 1 |
| 6 | Aluminium rim 2 bevels | 778 | 1 |
| 7 | Aluminium rim 1 bevel | 610 | 2 |
| 8 | Aluminium rim 1 bevel | 50 | 2 |
| 9 | fastening plug | | 2 |

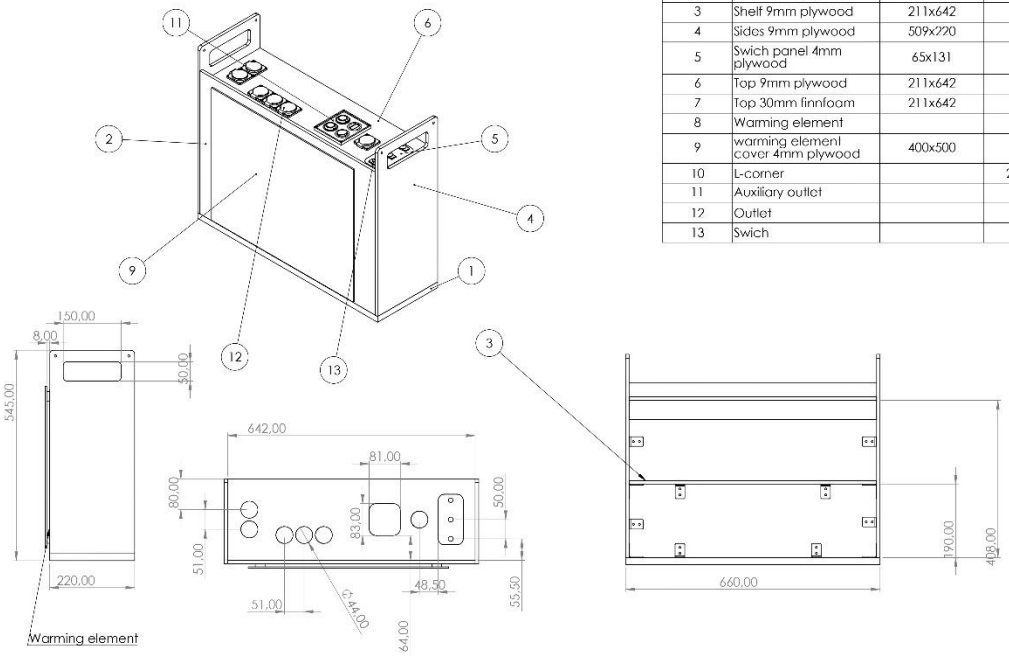



Technical drawings of the personal box lid



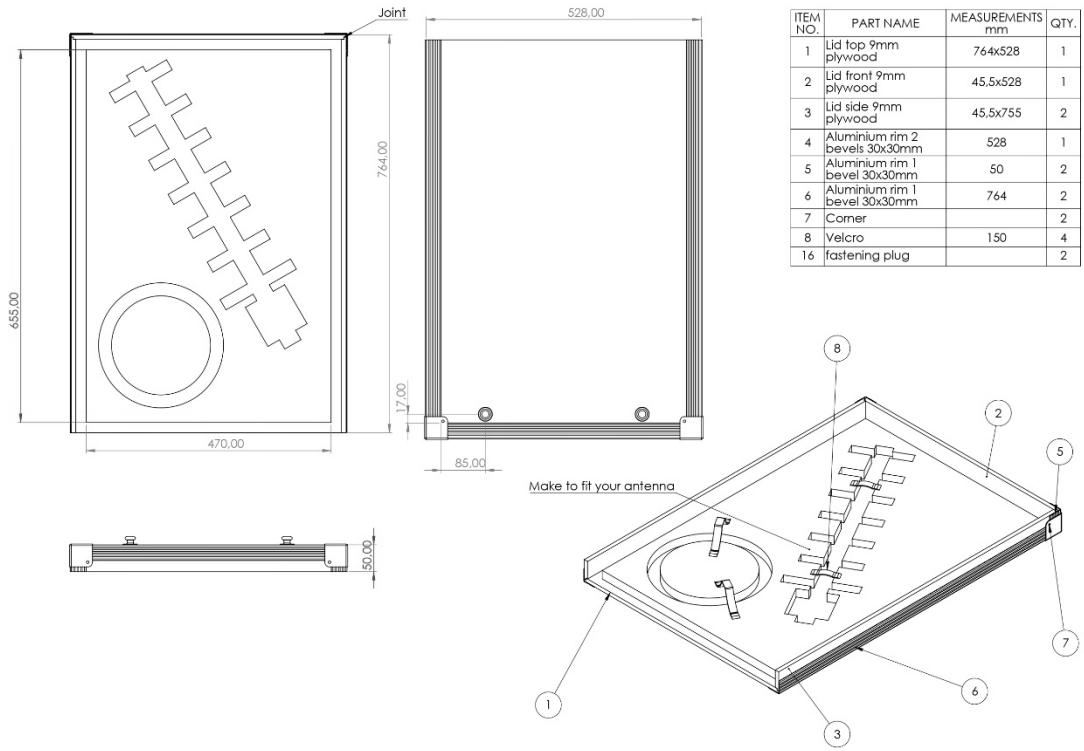

| ITEM NO. | PART NAME | MEASUREMENTS mm | QTY. |
|---|---|---|---|
| 1 | Bottom 9mm plywood | 500x750 | 1 |
| 2 | Front 9mm plywood | 586,5x491 | 1 |
| 3 | Left 9mm plywood | 586,5x750 | 1 |
| 4 | Right 9mm plywood | 586x750 | 1 |
| 5 | Back 9mm plywood | 586,5x491 | 1 |
| 7 | Corner | | 4 |
| 8 | Whole handle | | 2 |
| 9 | Cable entry | | 1 |
| 10 | Aluminium rim 1 bevel 30x30mm | 590 | 4 |
| 12 | Aluminium rim 2 bevels 30x30mm | 750 | 2 |
| 13 | Aluminium rim 2 bevels 30x30mm | 500 | 2 |
| 15 | Fastening ring | | 8 |
| 16 | Fastening plug | | 4 |
| 17 | Inside box 4mm plywood | 674x424x490 | 1 |
| 18 | Power outlet | | 2 |

Exploded blueprint of the electronic box



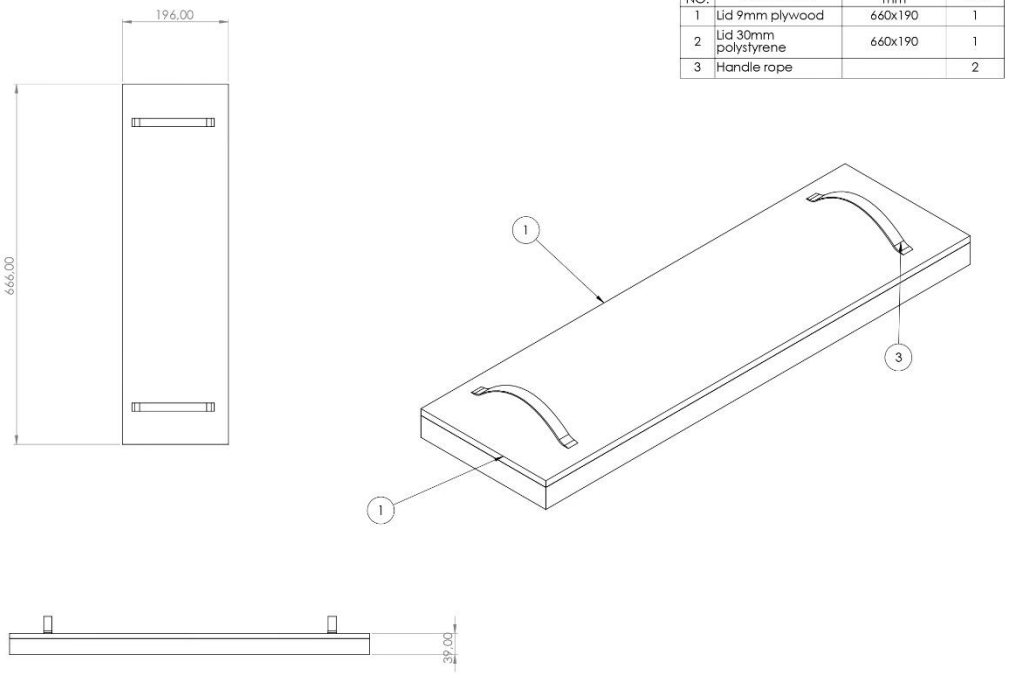

| ITEM NO. | PART NAME | MEASUREMENTS | QTY. |
|---|---|---|---|
| 1 | Bottom 18mm plywood | 220x660 | 1 |
| 2 | Front 9mm plywood | 454x642 | 1 |
| 3 | Shelf 9mm plywood | 211x642 | 1 |
| 4 | Sides 9mm plywood | 509x220 | 2 |
| 5 | Swich panel 4mm plywood | 65x131 | 1 |
| 6 | Top 9mm plywood | 211x642 | 1 |
| 7 | Top 30mm finnfoam | 211x642 | 1 |
| 8 | Warming element | | 1 |
| 9 | warming element cover 4mm plywood | 400x500 | 1 |
| 10 | L-corner | | 22 |
| 11 | Auxiliary outlet | | 1 |
| 12 | Outlet | | 6 |
| 13 | Swich | | 3 |

Exploded blueprint of the electronic rack



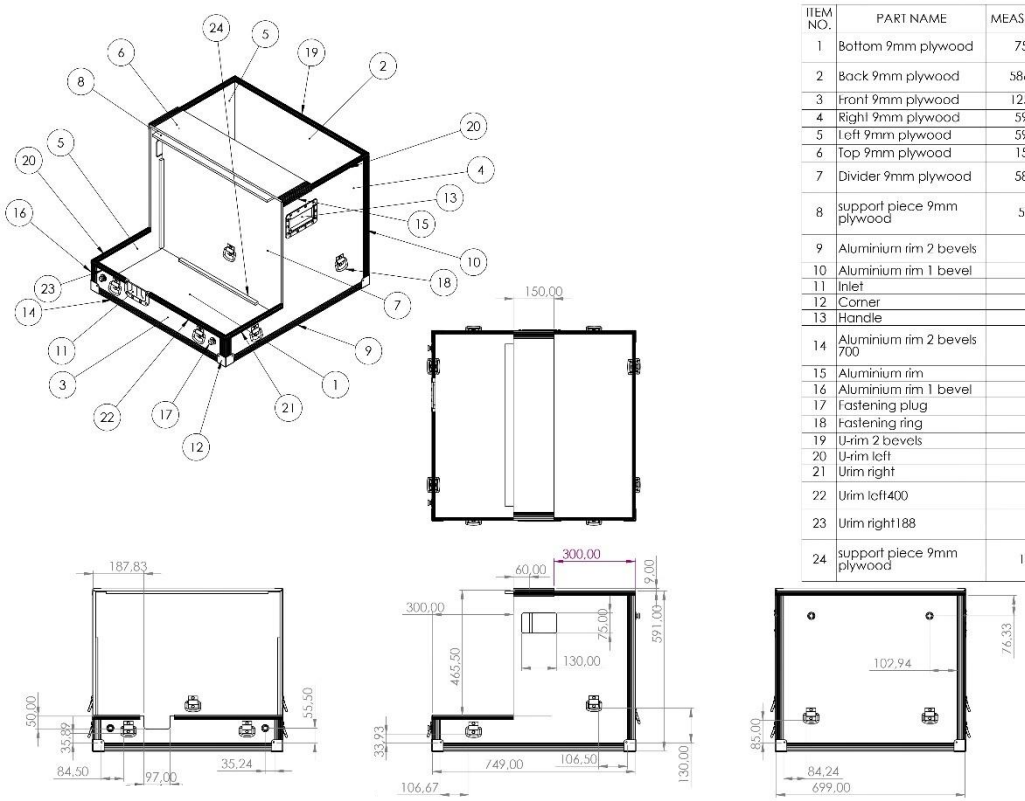

| ITEM NO. | PART NAME | MEASUREMENTS mm | QTY. |
|---|---|---|---|
| 1 | Lid top 9mm plywood | 764x528 | 1 |
| 2 | Lid front 9mm plywood | 45,5x528 | 1 |
| 3 | Lid side 9mm plywood | 45,5x755 | 2 |
| 4 | Aluminium rim 2 bevels 30x30mm | 528 | 1 |
| 5 | Aluminium rim 1 bevel 30x30mm | 50 | 2 |
| 6 | Aluminium rim 1 bevel 30x30mm | 764 | 2 |
| 7 | Corner | | 2 |
| 8 | Velcro | 150 | 4 |
| 16 | fastening plug | | 2 |

Technical drawing of the electronic box lid



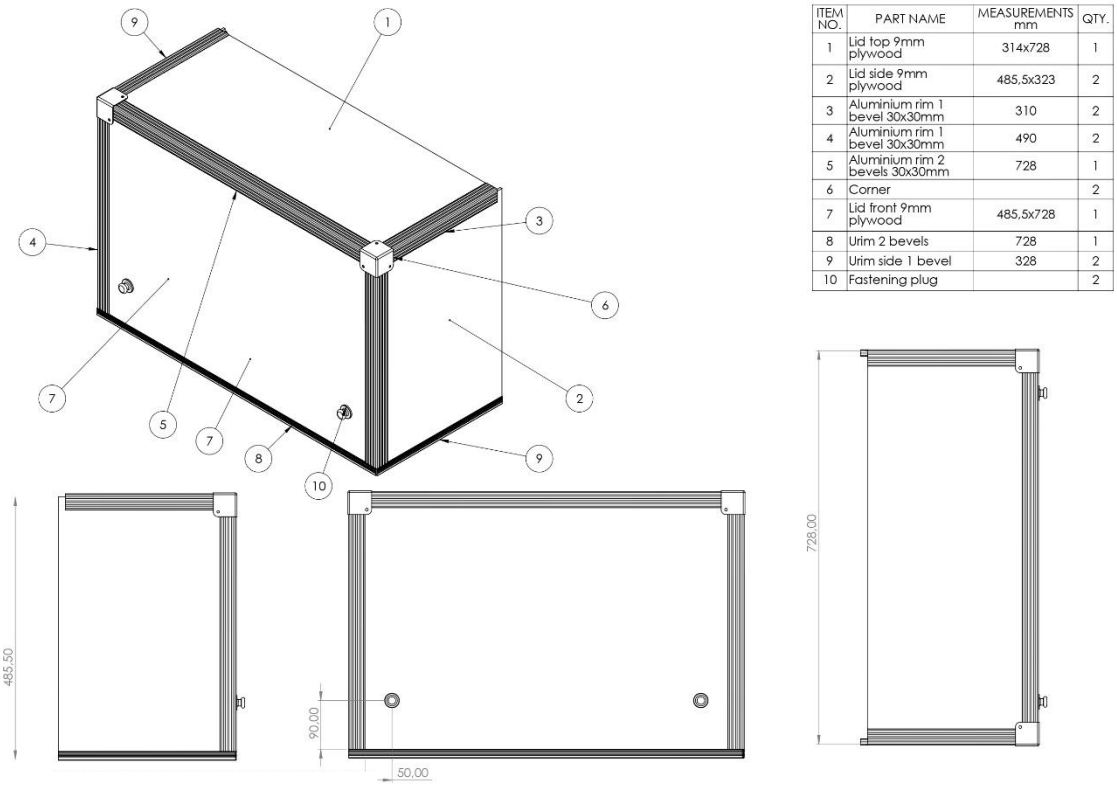

| ITEM NO. | PART NAME | MEASUREMENTS mm | QTY. |
|---|---|---|---|
| 1 | Lid 9mm plywood | 660x190 | 1 |
| 2 | Lid 30mm polystyrene | 660x190 | 1 |
| 3 | Handle rope | | 2 |

Technical drawing of the inside electronic box lid




| ITEM NO. | PART NAME | MEASUREMENTS | QTY. |
|---|---|---|---|
| 1 | Bottom 9mm plywood | 750x700 | 1 |
| 2 | Back 9mm plywood | 586,5x691 | 1 |
| 3 | Front 9mm plywood | 125,5x691 | 1 |
| 4 | Right 9mm plywood | 591x750 | 1 |
| 5 | Left 9mm plywood | 591x750 | 1 |
| 6 | Top 9mm plywood | 150x700 | 1 |
| 7 | Divider 9mm plywood | 582x682 | 1 |
| 8 | support piece 9mm plywood | 50x500 | 1 |
| 9 | Aluminium rim 2 bevels | 750 | 2 |
| 10 | Aluminium rim 1 bevel | 575 | 2 |
| 11 | Inlet | | 1 |
| 12 | Corner | | 4 |
| 13 | Handle | | 2 |
| 14 | Aluminium rim 2 bevels 700 | 700 | 2 |
| 15 | Aluminium rim | 150 | 2 |
| 16 | Aluminium rim 1 bevel | 115 | 2 |
| 17 | Fastening plug | | 4 |
| 18 | Fastening ring | | 13 |
| 19 | U-rim 2 bevels | 700 | 1 |
| 20 | U-rim left | 300 | 2 |
| 21 | Urim right | 300 | 2 |
| 22 | Urim left400 | 400 | 1 |
| 23 | Urim right188 | 188 | 1 |
| 24 | support piece 9mm plywood | 15x400 | 8 |

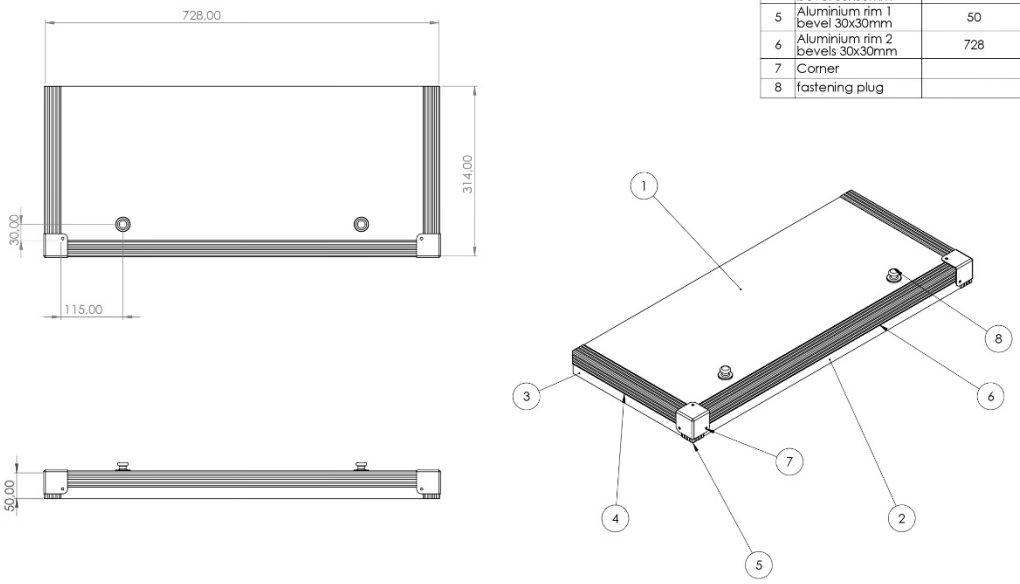
Technical drawings of the generator box



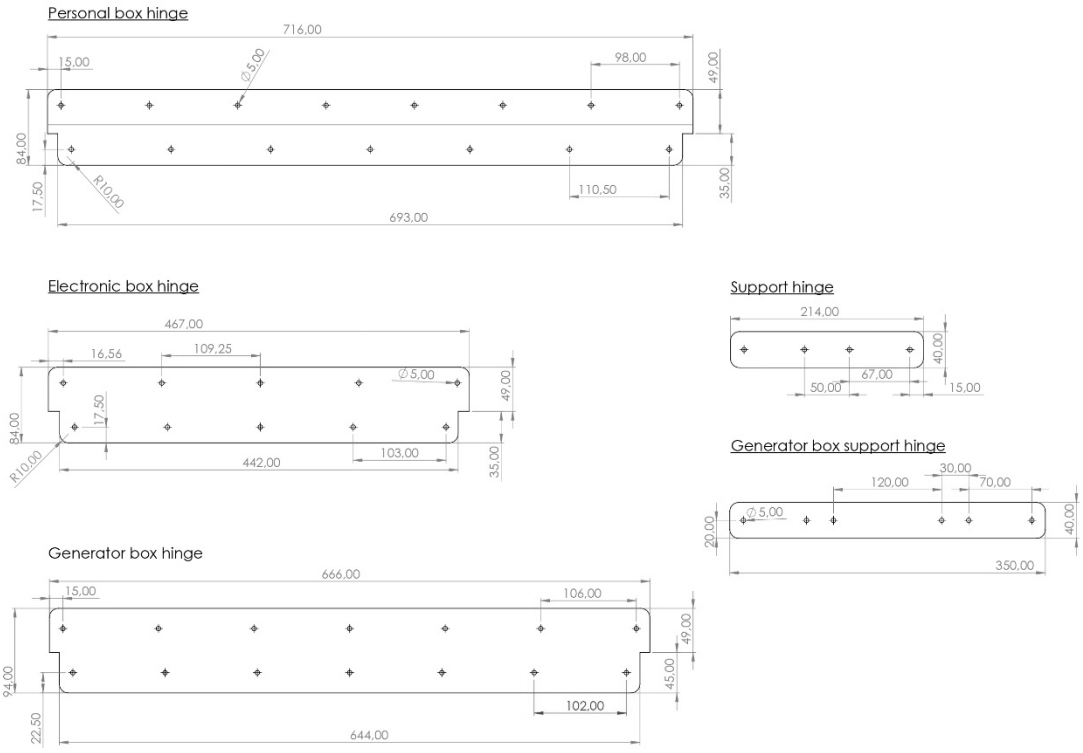

| ITEM NO. | PART NAME | MEASUREMENTS mm | QTY. |
|---|---|---|---|
| 1 | Lid top 9mm plywood | 314x728 | 1 |
| 2 | Lid side 9mm plywood | 485,5x323 | 2 |
| 3 | Aluminium rim 1 bevel 30x30mm | 310 | 2 |
| 4 | Aluminium rim 1 bevel 30x30mm | 490 | 2 |
| 5 | Aluminium rim 2 bevels 30x30mm | 728 | 1 |
| 6 | Corner | | 2 |
| 7 | Lid front 9mm plywood | 485,5x728 | 1 |
| 8 | Urim 2 bevels | 728 | 1 |
| 9 | Urim side 1 bevel | 328 | 2 |
| 10 | Fastening plug | | 2 |

Technical drawings of the generator box lid (1)

| ITEM NO. | PART NUMBER | MEASUREMENTS mm | QTY. |
|---|---|---|---|
| 1 | Lid top 9mm plywood | | 1 |
| 2 | Lid front 9mm plywood | | 1 |
| 3 | Lid side 9mm plywood | | 2 |
| 4 | Aluminium rim 1 bevel 30x30mm | 310 | 2 |
| 5 | Aluminium rim 1 bevel 30x30mm | 50 | 2 |
| 6 | Aluminium rim 2 bevels 30x30mm | 728 | 1 |
| 7 | Corner | | 2 |
| 8 | fastening plug | | 2 |




Technical drawings of the generator box lid (2)




Technical drawings of the hinges

*Materials*

The materials used were waterproof plywood (film faced plywood or "*filmivaneri*") for the main parts of the boxes, aluminum profiles for the edges and aluminum corners. To protect the electronics box, we applied a layer of urethane spray as a waterproof and insulating coating. Additionally, we lined the inside of the lid with thin foam to provide cushioning for the antenna.

*Process*

The boxes were designed based on the exterior design of the boxes used for musical instruments by "Thomann". This design incorporates aluminum profiles on the edges, which serve a dual purpose: on the one hand, they provide structural rigidity to the assembly, helping to keep the box surfaces at right angles; on the other, they contribute to the overall aesthetic of the product, adding a distinctive detail to the design. It should be noted that these profiles must be cut approximately 2 cm shorter than the length of the edge they cover, as the aluminum corners that will be attached later will have a rounded finish (not completely pointed) and, failing to do so, would require filing the edges of the box, which would compromise its structural integrity.

For assembly, all the pieces were cut, both those that make up the main body of the boxes and their lids. In the second stage of the process, a recess was made on the edges intended to fit at right angles with other pieces, leaving the upper edges of the sides of each box intact. For example, at the base of the box, this recess was applied to all sides; on the front panel, however, only three edges were recessed, leaving the top edge free of a lip.

The aluminum profiles were also cut to size, with an angled finish on those pieces that needed to align with other profile sections or with reinforcing corners. The corresponding holes for the pop rivets (expansion rivets) were also marked.

After this step, the plywood pieces were glued together and to the aluminum profiles, allowing them to dry for approximately three hours (or the time indicated by the adhesive used). The final holes for the pop rivets were then drilled, following the marks previously made in the aluminum.

The generator box includes a central dividing wall, which serves to separate the generator from the fuel bottles and also provides greater support for both the generator and the lids. This box features a more specialized design consisting of two lids (one larger than the other). The larger lid is intended to provide access for operating or servicing the generator itself. The smaller lid allows access to two fuel canisters, a power cable for connecting the generator, and a small toolbox.

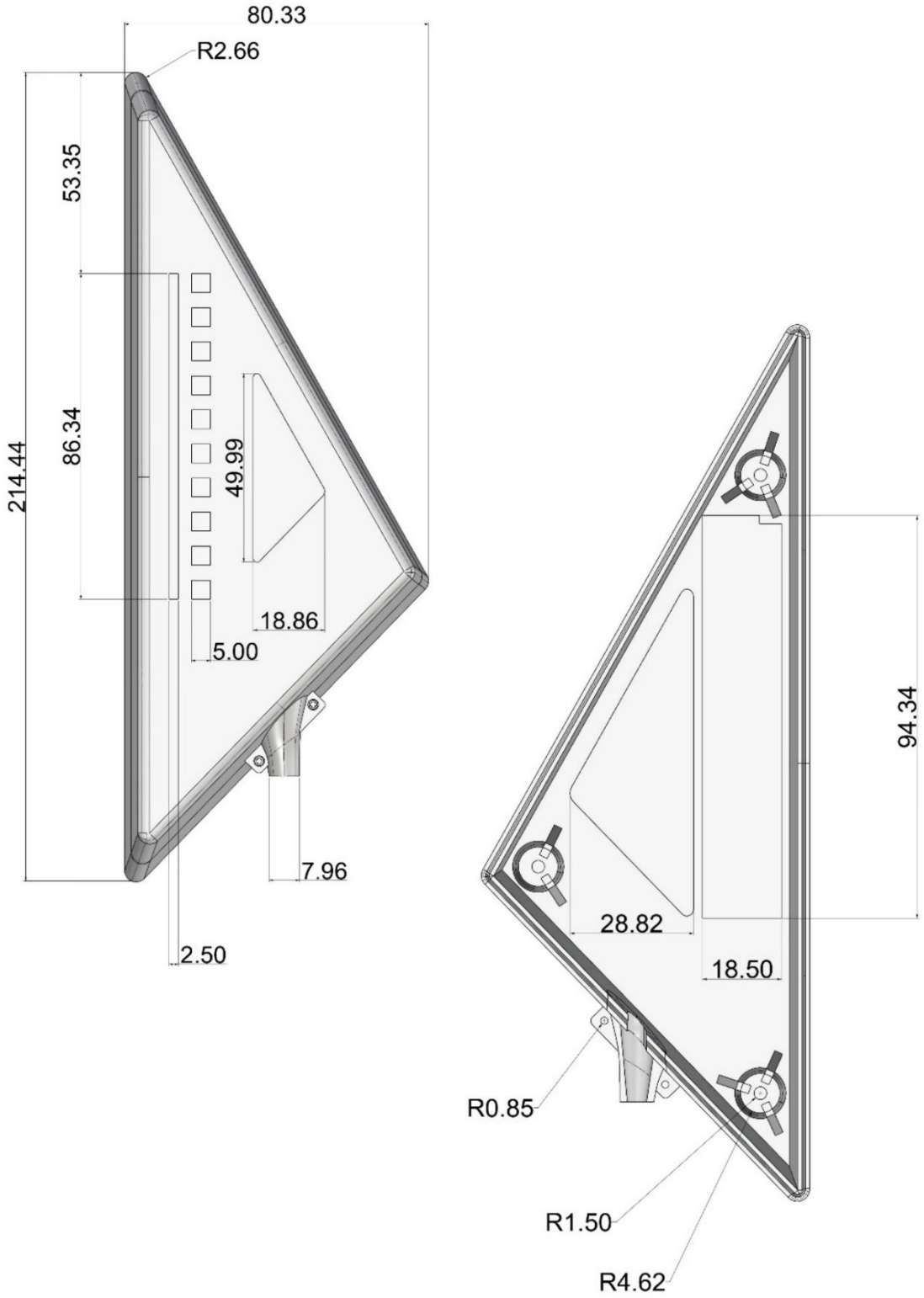
The other two boxes share an identical design, differing only in their dimensions and the positioning of the lid hinges. These hinges are made from cow leather, a material chosen for its optimal balance of durability and flexibility, it is more robust than reindeer leather and thinner than elk leather, making it particularly well-suited for this application.

When attaching the hinges, they were secured using pop rivets only. However, it may be advisable to consider adding adhesive as an additional measure to reinforce the bond and ensure the long-term stability of the hinges under repeated use and exposure to outdoor conditions, especially if the hinges get wet or frozen.

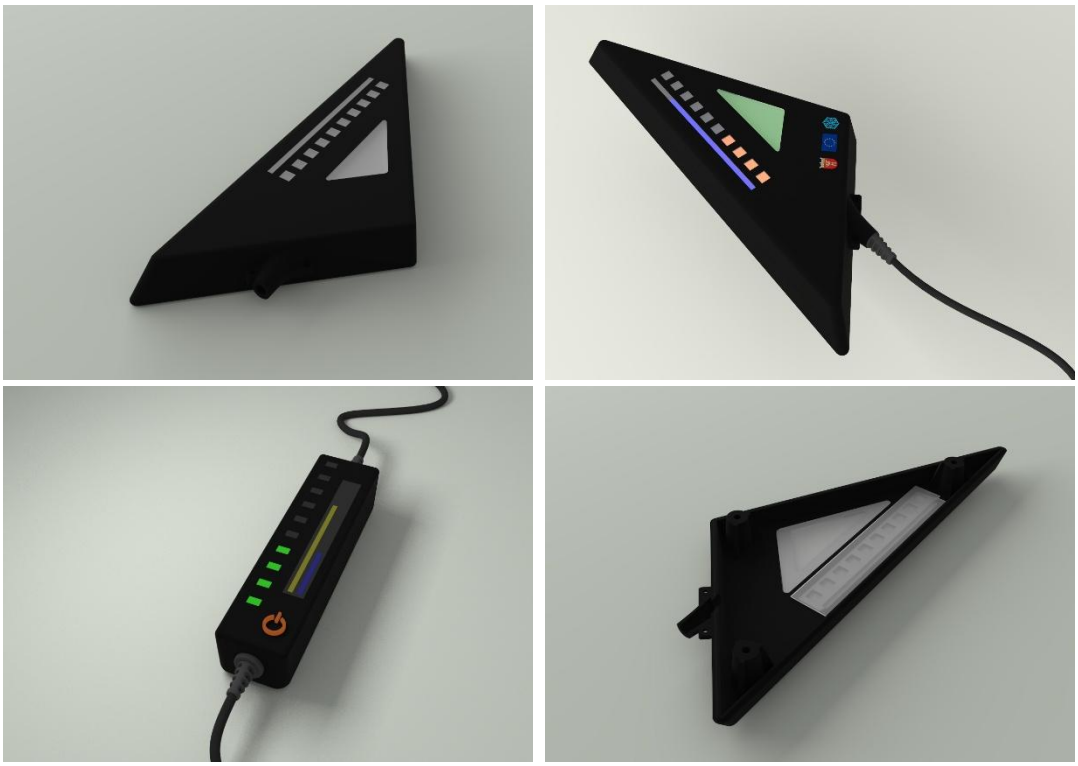
Finally, the side handles will be installed, also secured with pop rivets, as well as the aluminum corners that will reinforce the base and provide additional protection against possible impacts or damage.

## *Remote or signal indicator*

*Blueprints and renders*




Technical drawings of the controller with measurements



Renders of the final remote, with and without the lights on

*Materials*

PLA

*Process*

The process is straightforward: simply 3D prints the controller file using either a resin-based PLA printer or a filament-based FDM printer, depending on your preferred material and resolution requirements. It could be more weather resistant if you apply a final paint coat or resin protection.

The next step involves mounting the main PCB, soldering the control LEDs, and positioning each lighting component within the two halves of the controller housing.

Finally, the two halves are assembled and secured using small screws inserted from the rear side the one without the light indicators.

## Final results

Photos of the wooden sled and the toboggan functioning in the snow in Rostojärvi

## Field Trip: results and lessons learned in Rostojärvi

The concept sled functioned properly, and the overall design of the transport boxes was a success, with only minimal changes being required. Both sleds withstood the entire journey, despite being subjected to rough and demanding conditions intentionally.

The electronics box performed particularly well, with the heating system functioning flawlessly throughout the trip. To assist in protecting the electronics, they were coated in a layer of urethane spray, which helped to insulate and provide water resistance. Thin foam was also installed inside the lid to assist in reducing vibrations and to provide extra cushioning.

However, there were a few issues that were discovered. The materials used to build the antenna pole were not sufficient and should be reconsidered in future models. The boxes need to have their heights decreased so they will not bump into one another during movement. Furthermore, the angle of the toboggan should be modified to accommodate smaller snowmobiles more effectively. Anchor points for the guy wires holding up the antenna pole should also be reinforced. Despite this, the antenna was able to provide a signal temporarily, facilitating successful message reception and, in some cases, transmission.

The rubber bands used in this project performed extremely well. They kept the lids and the boxes themselves securely in place, even while traveling at high speeds and over rough terrain. The placement design of the boxes and the orientation of the lids functioned well, with access being simple during use. The implementation of different types of lids for different boxes was also helpful to the usability of the system. Although the boxes are slightly heavy when empty, they are still manageable and can be dealt with by one person if necessary. The external material of the boxes resisted the environmental conditions nicely; there was not any excess snow or ice collection.

On day one, while it was snowing, the snow flowed under the boxes instead of over the toboggan, which maintained function.The plastic on the toboggan base was strong and withstood various surfaces. Although there were a few scratches caused by stones, these did not detract from overall performance.

Following the snowstorm and a temperature change, some ice had developed on the handles and between the boxes and the bottom frame of the toboggan. This was easily corrected using a rubber mallet, which simply knocked the ice off without doing any damage.

There was ample space in the boxes for personal equipment. The leather in the hinges was somewhat loose but functioned satisfactorily; it did not freeze and was of the proper thickness to bend without cracking.

The cleats on the wood sled performed satisfactorily. It is recommended, however, that guide strips be mounted on the bottom of the bag sled runners for improved tracking and stability.

Photos of the final prototypes in Rostojärvi
Photo (1) and photo (2) assembling the pole for the antenna
Photo (3) photo (4) and photo (5) toboggan after the snow storm
Photo (6) wooden sled after the snow storm




Photo (1) wooden sled the first day with the boxes attatched with space in between
Photo (2) toboggan with the antenna pole cilinder detail
Photo (3) and photo (4) photos of the wooden sled after the snow storm